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ABSTRACT

This urban transportation pamphlet delves into the roles of policy groups and technical staffs in evaluating alternative transportation plans, evaluation criteria, systems to evaluate, and evaluation procedures. The introduction admits the importance of subjective, but informed, judgment as an effective tool in weighing alternative transportation plans, together with evaluation of roles, procedures, goals, costs, employment, land utilization, the tax base, accessibility, and social considerations The environment is stressed throughout the pamphlet. "Out of this vast collection of data must emerge those items of data necessary for a group of normally nontechnical, policy-oriented individuals to render intelligent judgments concerning the relative merits of plan alternatives," states the conclusion. Charts, graphs, and tables are liberally used. (NH)

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U.S. DEPARTMENT OF TRANSPORTATION
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WASHINGTON, D.C. 20590

URBAN TRANSPORTATION PLANNING SHORT COURSE

Evaluation of Alternative Transportation Systems

NOTE:

Contents

		Page
I.	Introduction.	1
II.	The Roles of Policy Groups and Technical Staffs in Evaluating Alternative Plans	2
III.	Evaluation Criteria	7
IV.	Systems to Evaluate	17
V.	Evaluation Procedures	19
VI.	Conclusion.	27

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Evaluation of Alternative Transportation Systems

I. INTRODUCTION ("Evaluation: To Examine and Judge")

The urban transportation planning process may be viewed as a vehicle for providing rational information to decisionmakers and the public concerning the allocation of transportation resources. One of the most basic and widely accepted means for conveying this information is the long range regional transportation plan. The development of a comprehensive long range transportation plan normally consumes a major share of the manpower and budget of an urban transportation planning program. Representing a current concept of a future regional transportation system at some point in the distant future (20 to 25 years), the long range plan should serve as the basis for key transportation improvement decisions within a metropolitan area, including the development of short range improvement programs, annual capital budgets, and project planning.

The adoption of a long range plan to guide investments in urban transportation facilities normally occurs upon the completion of an orderly process of developing and testing a wide range of alternative future land use/ transportation configurations, narrowing the possibilities to a relatively small number of basic alternatives, and performing an in depth evaluation of each to determine which plan can best serve community objectives. The process of plan evaluation can be quite complex, due not only to the almost infinite variety of possible alternatives, but perhaps more significantly due to the vast array of possible criteria by which plans may be judged. Many of these evaluation criteria are quite subjective and difficult to forecast with accuracy. Yet, increasingly, it is the more subjective and elusive criteria that are having the strongest influence on transportation related decisions.

Techniques have arisen within the past decade which attempt to accommodate these seemingly incompatible mixes of evaluation criteria by applying ranking, weighting, and scaling mechanisms. While useful as tools for relating a multiplicity of diverse factors, these techniques are limited in terms of thier ability to overcome the need for subjective judgment. More and more, it is beginning to appear that subjective, but informed, judgment will be recognized as the effective tool it always has been in weighing alternatives, making the necessary tradeoffs and performing the evaluations required for the rational selection and adoption of a land use/transportation plan.

II. THE ROLES OF POLICY GROUPS AND TECHNICAL STAFFS IN EVALUATING ALTERNATIVE PLANS ("Not to Decide is to Decide")

It is unfortunate that there are many who view transportation system evaluation as just another technical element of the urban transportation planning process, when in fact, the role of the policy maker should be far stronger than that of the technician in this phase of transportation planning. The flow diagram shown in figure 1 is offered as an example of the major role to be played by elected officials and their representatives in the developing, testing, evaluating, and adopting of transportation/land use plans. At the risk of oversimplifying a complex political and technical process, the illustration points out that virtually every step requires some degree of input from a policy group, ranging from the formulation of alternatives for initial testing through the adoption of the long range plan and program.

A. Policy Group Role

The role of the policy group which oversees and guides the overall planning effort is basic to the evaluation process. It includes the following major activities:

1. Adopt Regional Goals and Objectives

The development of a viable planning guide for future growth rests upon a foundation of knowledge of the community's aspirations and needs. It is the responsibility of a policy group to see to it that the necessary studies and programs are conducted to enable the development of a set of community goals and objectives. It is further the responsibility of this policy group, acting as representatives of the various interests within the community, to adopt meaningful goals and objectives to guide the development of alternative plans.

2. Approve Alternatives for Testing and Evaluation

The decision as to which alternatives should be subject to initial testing, and which to indepth evaluation should not be left to the sole discretion of the technical staff. While professional staff members may provide information and advice concerning possible alternatives, the responsibility of the policy group for ultimate plan adoption renders as virtually self-evident the need for this same group to subscribe to the variety of alternatives to be examined.

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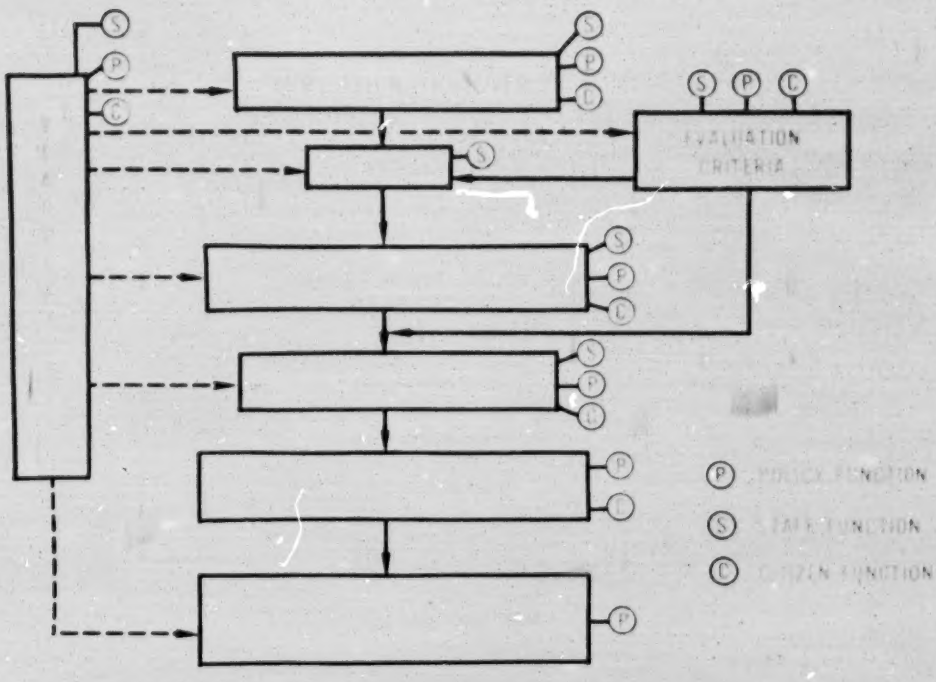
CONTINUING EVALUATION PROCESS



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TRANSPORTATION SYSTEM EVALUATION

POLICY GROUP ROLE

- ADOPT REGIONAL GOALS AND OBJECTIVES
- APPROVE ALTERNATIVES FOR TESTING AND EVALUATION
- SELECT EVALUATION APPROACH AND APPROVE EVALUATION PROCESS
- DESIGNATE MECHANISMS FOR CITIZEN INVOLVEMENT
- WEIGH ALTERNATIVES AND SELECT PLAN FOR ADOPTION
- ADOPT LONG RANGE PLAN AND SHORT RANGE PROGRAM

3. Select Evaluation Approach and Approve Evaluation Process

As will be evident later in this paper, the nature of the evaluation process is such that it may be strongly influenced by the particular set of techniques chosen. It is therefore quite important that the group expected to reach a decision should have a strong voice in accepting, rejecting, or modifying to suit its needs, the particular method by which the decision is to be reached. If the evaluation procedure is selected by the professional staff, it should be with the full awareness and approval of the policy group.

4. Designate Mechanism for Citizen Involvement

One of the more critical issues confronting the planning profession concerns the question of community involvement. Although the determination of effective means of providing for citizen participation in developing long range plans remains a perplexing problem for members of technical staffs, it must be remembered that government agencies exist to implement the programs and decisions of elected officials, and that any mechanism developed for providing a greater degree of citizen participation must have the official blessing of these decisionmakers.

5. Weigh Alternatives and Select Plan for Adoption

Quite frequently the efforts of a technical staff in developing information concerning the attributes of plan alternatives are mistakenly considered to represent the entire evaluation process. In fact, the evaluation of alternatives and selection of a plan represent actions which are largely the responsibility of the policy group. While it is the role of the staff to provide information necessary for the evaluation of alternatives, the assimilation of this information, the weighing of advantages and disadvantages, and the ultimate choice of a single "best" plan should take place within a policy forum.

6. Adoption of Long Range Plan and Short Range Program

The fruition of the evaluation process consists of an action by the policy body toward formal adoption of the long range plan, and a short range improvement program

based upon the plan. With this degree of acceptance of the plan, it should become the standing policy of all participating governments and agencies to adhere to the plan and program in implementing transportation improvements. At such time as they are no longer useful nor relevant in guiding regional transportation decisions, the plan and program should undergo redevelopment under the direction of the policy group.

B. Staff Role

It is fundamental to the concept of government planning in a democratic society that the role of the professional planner is not to adopt and implement plans, but to provide the necessary information and advice for elected officials and their representatives to reach these types of decisions. The following represents some of the basic functions of the professional planning staff in evaluating transportation and land use alternatives.

1. Develop Technical Procedures

Perhaps the key role to be played by a professional planning staff involves the development and application of technical procedures capable of accounting for the complex phenomenon associated with urban development and transportation systems dynamics. It is at this point that the planner demonstrates why his skill and training allow him to provide information and data to decisionmakers which would be available from no other source, and which are uniquely tailored to the needs of the decisionmaker and the community.

It is essential that the professional planner take time to communicate with his sponsors in terms comprehensible to them, generally how his techniques work, what assumptions he has made, and why the information he has developed should be used in reaching decisions.

2. Recommend System Alternatives to Test and Evaluate

While the responsibility for final designation of alternative plans for testing and evaluating remains with a policy oriented body, the experience and professional wisdom of the technical staff is an invaluable resource in suggesting possibilities, and in generally broadening the horizons of policy groups.

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TRANSPORTATION SYSTEM EVALUATION

STAFF ROLE

- DEVELOP TECHNICAL PROCEDURES
- RECOMMEND SYSTEM ALTERNATIVES TO TEST AND EVALUATE
- SUGGEST POSSIBLE EVALUATION APPROACHES TO POLICY GROUP
- PROVIDE NECESSARY DECISION INFORMATION
- COMMUNICATE WITH PRIVATE CITIZENS
- RECOMMEND A PLAN AND SHORT RANGE PROGRAM

3. Suggest Possible Evaluation Approaches to Policy Group

Since the selection of an evaluation procedure can have an important bearing upon the entire evaluation process, it is important that the staff delineate clearly for the policy group specifically what evaluation procedures are available, and what are the strengths and weaknesses of each. While the staff may suggest an approach, the selection of an evaluation technique ought to be subject to the approval of the policy body.

4. Provide Necessary Decision Information

The exercising of evaluation techniques by a technical staff should be thought of not as a decision technique, but as an information generating function. Once again, the staff's role is to provide the information required by a policy group to reach decisions. This information should be clear, concise, timely, relevant, and specifically tailored to each unique decision requirement. Conveying effective and useful information to policy groups, as well as to the public, is a difficult process which most technical staffs have yet to master.

5. Communicate With Private Citizens

As indicated earlier, developing effective means for communication with, and participation of private citizens remains one of the planners most difficult and frustrating problems. Within the context of ground rules established by a policy group, the professional staff faces the challenges of (a) identifying the multiplicity of citizen interests within the community, (b) identifying credible spokesmen from the community, (c) arousing citizen interest in the development of a long range regional plan, and (d) translating the often conflicting inputs gained from the community into plan alternatives which are generally acceptable to both policy makers and the community.

6. Recommend a Plan and Short Range Program

While at this point it should be apparent that the selection and adoption of a plan and program are the responsibility of the policy group, the wealth of knowledge available to a professional staff, in conjunction with the planner's ability to play an objective and even handed role, makes it quite desirable, as a rule, for the planning

TRANSPORTATION SYSTEM EVALUATION

CITIZEN ROLE

- PARTICIPATE IN THE FORMULATION OF REGIONAL GOALS, OBJECTIVES, AND EVALUATION CRITERIA
- PARTICIPATE IN THE DEVELOPMENT OF ALTERNATIVE PLANS
- COMMUNICATE WITH POLICY GROUP AND TECHNICAL STAFF MEMBERS
- PARTICIPATE IN THE EVALUATION PROCESS
- PARTICIPATE IN THE PLAN SELECTION ACTION
- MAKE BOTH NEGATIVE AND POSITIVE OPINIONS KNOWN TO DECISION-MAKERS

staff to reach some sort of recommendation as to which alternative it feels should be adopted. Naturally, the degree to which a staff position is heeded, or even solicited, depends entirely upon the unique circumstances of each individual transportation planning program.

III. EVALUATION CRITERIA ("It Is Impossible to Judge a Book By its Cover Alone")

The evaluation of alternative transportation plans is a process which attempts to measure the ability of plans to achieve stated transportation goals and objectives. It, therefore, is necessary to delineate transportation goals and objectives within the framework of more general development objectives before the evaluation process begins. Actually, goals and objectives should be developed early in the planning process and used in plan formulation as well as in evaluation.

The goals of a region should be those of the people and not of the planning staff. It is, therefore, desirable to involve the largest possible number of people in their formulation. Policy committees, technical committees, citizen committees, and committees composed of the power structure of the community have been used successfully in this area. Some studies have taken surveys, sponsored discussion groups, or held public hearings to assist in developing community goals and objectives. It is important that these goals and objectives be formally adopted by the policy making bodies of the region.

Evaluation criteria represent the standards by which alternative plans are judged in terms of their ability to satisfy adopted goals and objectives. As such, they are the basic yard sticks for measuring those attributes of each alternative which have been identified as having a strong bearing on the ultimate selection of a plan. As stated earlier, it is the responsibility of the professional staff to indicate possible criteria in each goal area, to develop the necessary information in an objective and reliable way, and to furnish this information to policy groups in a comprehensible manner. The final selection of evaluating criteria, however, should be made by the policy group after it is fully briefed as to what possibilities exist.

As an example of the process of developing an acceptable set of evaluation criteria, consider a regional goal to minimize disruption caused by transportation improvements, and an associated objective to keep the number of dwelling units taken for right-

of-way acquisition below a stated maximum. In developing evaluation criteria to measure how well each alternative meets such a goal and objective, the most obvious becomes the "number of dwelling units taken." There are other ways of measuring and analyzing dislocations, however, and these should be explained carefully to the policy group. For example, dislocations can be measured in terms of percent distributions by race, or by income group, or by political jurisdiction. The estimated number of dislocations associated with each alternative can be subtracted from the number of joint development opportunities for additional housing. Finally, the number of dislocations per year can be compared to historical annual rates to lend a better scale, and greater meaning to the numbers being considered.

Thus, for any particular objective, there normally exists a large variety of possible evaluation criteria. Each individual criterion, however, is normally quite limited in its ability to provide a complete indication of how well a particular plan may satisfy a stated objective. Furthermore, criteria should be couched in terms which lend meaning to the often unfathomable array of numbers produced in a plan evaluation process.

There are three basic types of evaluation criteria; costable, quantifiable, and qualitative. They may be defined as follows:

Costable Criteria - Those criteria which can be measured in terms of dollar costs and benefits.

Quantifiable Criteria - Those criteria which may be measured directly in terms of numerical quantities.

Qualitative Criteria - Those criteria which may be described directly only according to subjective means (but may ultimately be quantified somewhat through ranking and scaling techniques).

Figure 2 shows several examples of each type of evaluation criteria, as they reflect system user, and external attributes of each plan alternative. The following discussion delves a little more deeply into a few of the more commonly applied evaluation criteria.

A. Total Transportation Cost

The past several years has witnessed a noticeable shift away from the use of costable factors as the sole criteria

Figure 2 - Examples of Evaluation Criteria

Type of Attribute	Type of Criteria		
	Costable	Quantifiable	Qualitative
System	Construction Right-of-Way Transit Vehicles Maintenance Transit Operations	Miles of System by Class and Location Transit Seat Miles Average Freeway Spacing Transit Vehicle Headways	Aesthetics
User	Private Vehicle Operation Accident Costs Traveltime Costs (Through Value of Time) Fares	Accessibility Measures Vehicle-Miles of Travel Percent Transit Use Trip Length Effective Speed	Comfort Convenience Visual Aspects from the Road
External	Change in Property Values Tax Base Extra Relocation Payments Construction of Replacement Housing	Air Pollution Number of Dislocations Land Consumption Noise	Neighborhood Disruption Psychological Attitudes

ECONOMIC CONSIDERATIONS

- Employment availability
- Land utilization and joint development
- Tax base

for plan evaluation. The trend has been towards a more balanced view, with costable criteria becoming just one member of a broader group of criteria. Nevertheless, the ability to weigh the costs of each alternative remains one of the planners most reliable and accepted ways of judging the effectiveness of alternative plans.

A particularly useful approach toward balancing the dollar costs and benefits of alternative plans was applied 15 years ago in the original Chicago Area Transportation Study. The technique illustrated in figure 3 recognizes that virtually all costs of transportation service must ultimately be born by members of the public, both in the form of direct costs involved in using transportation facilities, and in the less direct way of paying taxes which are ultimately used to provide transportation facilities. As shown in figure 3, the total transportation cost is therefore the sum of the costs associated with the use of transportation facilities and the cost of providing these improvements. Quite naturally, the greater the degree of transportation improvement, the higher the costs of providing the improvements. On the other hand, as the degree of improvement increases, the costs of using the facilities (such as operating, traveltime, and accident costs) decrease. However, the rate at which user costs decline is itself decreasing. Thus, the first "X" dollars spent for transportation improvements, if invested wisely, will produce a greater reduction in user costs than the second "X" dollars, and so on.

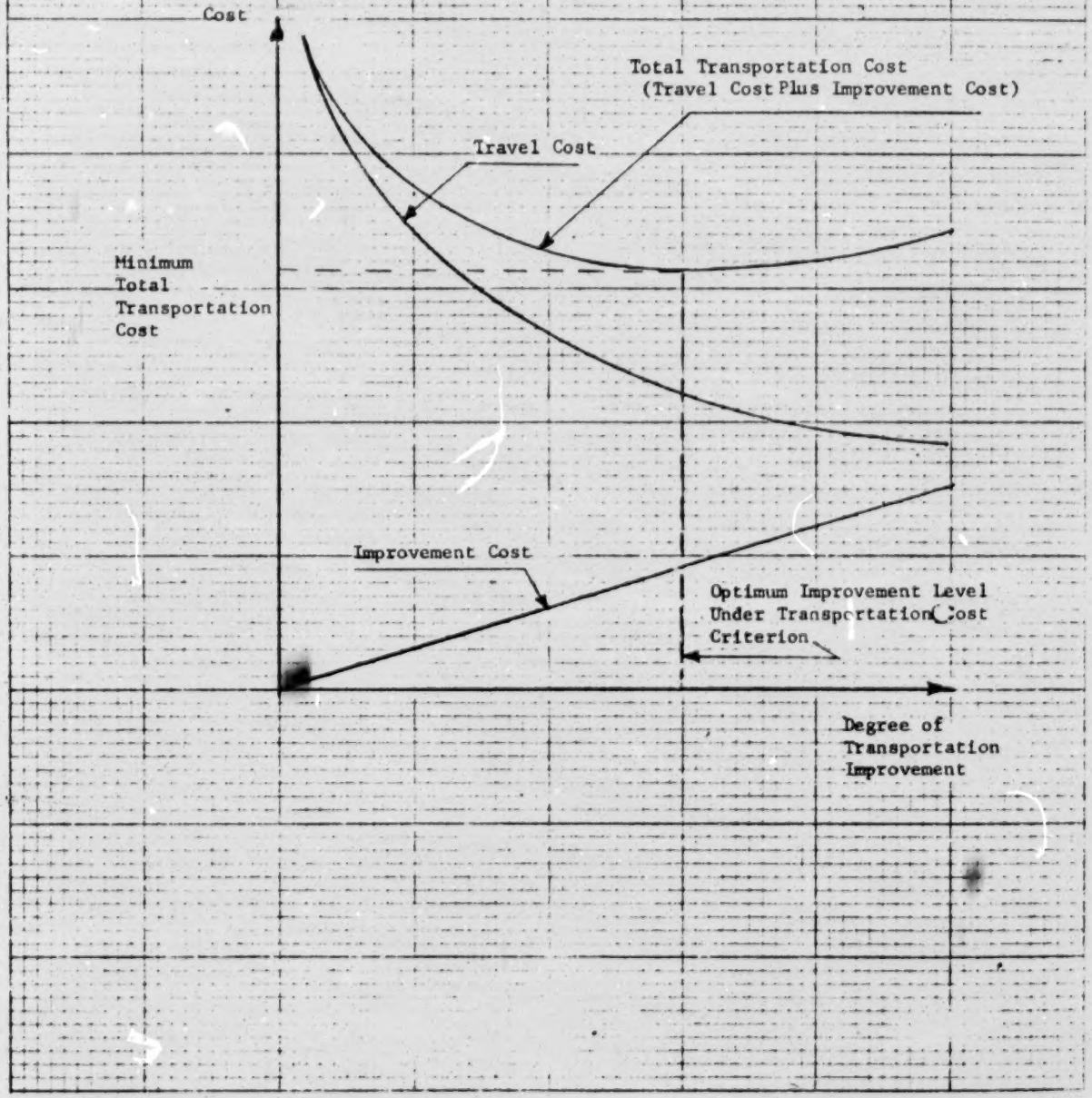
From figure 3, it can be seen that the total transportation cost, which is the sum of the costs of providing capacity and the costs of using the facilities, reaches a minimum point. This minimum point, by definition, occurs when an added dollar toward providing capacity produces less than a dollar savings in user costs. Naturally, this economic analysis is performed using appropriate economic techniques to account for both the variation in costs over the 20- to 25-year time horizon as well as the time value of money, or discount rate.

B. Accessibility

The concept of accessibility has been developed as a basic indicator of the ability of a transportation system to provide efficient service among areas of activity within a planning region. There are numerous ways of measuring and displaying accessibility indicators. These include the

Figure 3

Example of Total Transportation Cost Evaluation Criterion



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SOCIAL CONSIDERATIONS

Community cohesion

Displacement, disruption, relocations

Neighborhood stability

Housing availability

Accessibility

Social and community services

Title VI

- IDENTIFY ENVIRONMENTAL CONDITION
  - Collect environmental data
  - tap existing data sources
- IDENTIFY ENVIRONMENTALLY SENSITIVE AREAS
- PERFORM SYSTEM AND CORRIDOR LEVEL ENVIRONMENTAL STUDIES
- INVOLVE THE PUBLIC
- LOOK AT REASONABLE ALTERNATIVES

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WHAT ARE ENVIRONMENTAL CONSIDERATIONS

- AIR QUALITY
- NOISE LEVELS
- WATER QUALITY
- PHYSICAL EFFECTS
- ECOLOGICAL IMPACTS
- OTHER

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ANALYSIS TECHNIQUES

- MAPPING
  - overlays
  - contours
- ENVIRONMENTAL MATRIX
- COMMUNITY VALVES
- ENVIRONMENTAL CAPACITY APPROACH
- CASE STUDIES

A COORDINATED CONSIDERATION OF NOISE IMPACTS

SYSTEM LEVEL

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- DEVELOP COMMUNITY VALUES AND GOALS
- AREA WIDE DATA COLLECTION
- MAP EXISTING SITUATION
- APPLY STANDARDS
- DEVELOP AND CONSIDER ALTERNATIVE CORRIDORS
- EVALUATION OF ALTERNATIVES AND SELECTION OF CORRIDORS

development of mathematical indices (such as the denominator of the gravity model) and the use of graphical displays (such as isochronal maps and data plots). The key questions to be considered in analyzing accessibilities among and within alternative transportation plans concern:

1. Accessibility for which groups (low income, high income, central city, suburbs, etc.).

2. Accessibility to what activities (employment, shopping, social, health services, etc.).

3. Accessibility by which mode of transportation (transit, private vehicles, commerical vehicles, etc.).

4. Accessibility during what time of day (peak, off-peak).

Figures 4 and 5 and table 1 illustrate three techniques for viewing accessibility. Figure 4 shows a graph which depicts the percentage of unskilled jobs within a region which can be reached by low income residents of a particular district under each of two alternative plans. Under this example, Plan B is superior to Plan A in terms of providing low income residents of District I with peak hour public transportation access to suitable jobs. Similar graphs may be developed for any number of combinations of accessibilities and incorporated into the overall plan evaluation process at the discretion of the staff and policy group.

Figure 5 depicts the use of an isochronal map to reflect relative traveltimes from one part of a region to all other parts. An isochronal map is simply a map showing lines which connect points of equal traveltime from a particular locality. (The lines are called isochronals, or traveltime contours.) The same types of stratifications used in figure 4 are, of course, possible here as well.

Table 1 illustrates yet another measure of accessibility, i.e., effective speed. Effective speed simply involves measuring the airline distance covered in a particular time period spent traveling between two points. The underlying concept is that people, if they were able to do so, would travel between points in a straight line, or airline distance. The time required to cover this distance is a measure of the service provided by a transportation system. The data shown in table 1 show effective speeds for work trips stratified by income group, auto availability, and location.

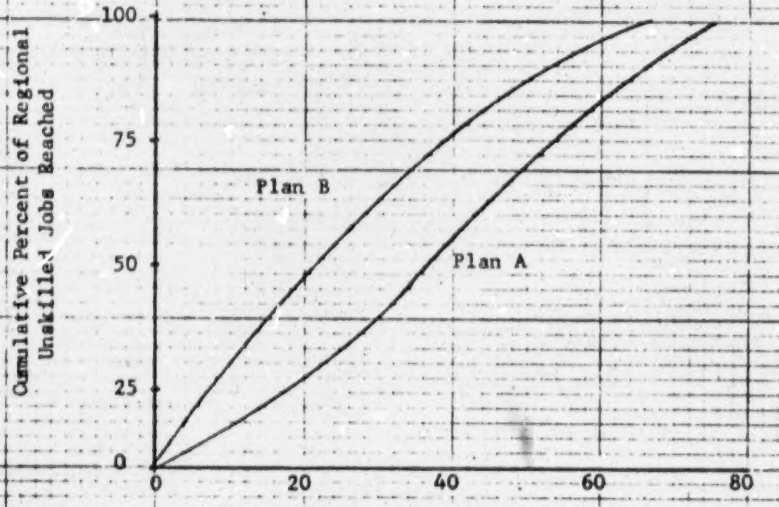

Figure 4

Example of Accessibility Data Plot

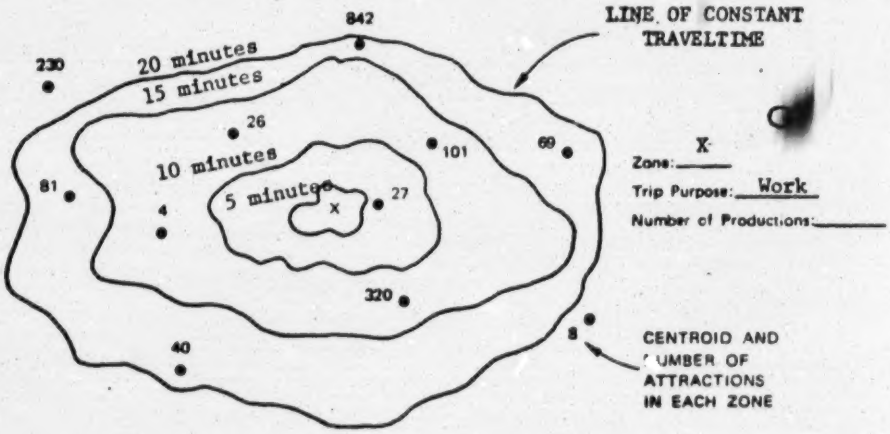

FIGURE 5 TYPICAL ISOCHRONAL MAP

Source: "Methods of Evaluation of the Effects of Transportation Systems on Community Values," SRI, 1971.

Table 1

Average Miles* Covered Per Ten Minutes of Work Trip Traveltime

Residential Location	Autos Available	Household Income: Under $4,000	Household Income: $4,000 - $10,000	Household Income: Over $10,000
New York City (excluding Richmond)	0	1.0	1.2	1.4
	1+	1.4	1.6	1.7
Outside New York City (including Richmond)	0	1.0	1.6	1.9
	1+	1.9	2.5	3.1

* Airline Distance

Source: H. Kassoff and H. Deutschman, "Transportation: The Link Between People and Jobs, " Highway Research Record 322.

C. Analysis of External Effects

The degree to which so-called "external" consequences of transportation improvements have grown importance is reflected by the major concern over disruption and dislocations caused by large scale transportation improvements. Table 2 and figure 6 illustrate techniques for developing and displaying such information for the purposes of plan evaluation.

Table 2 simply depicts the numbers of residences dislocated for each of five alternatives (including the existing plus committed). The important point to be gained from this table is the need for disaggregating gross statistics into meaningful stratifications. For example, total estimated residential dislocations tell only part of the story. By stratifying according to income group, or race, or location, much can be learned in terms of possible inequitable hardships that would be masked by treating only aggregate statistics.

Table 2

Sample Analysis of Residential Dislocations by Income Group

Plan Alternative	Number of Dwellings Dislocated (By Income Group)			Total Dwellings Dislocated
	Low	Middle	High	
Existing + Committed	85	60	5	150
A	400	75	5	480
B	250	125	15	390
C	150	175	50	375
D	75	175	75	325

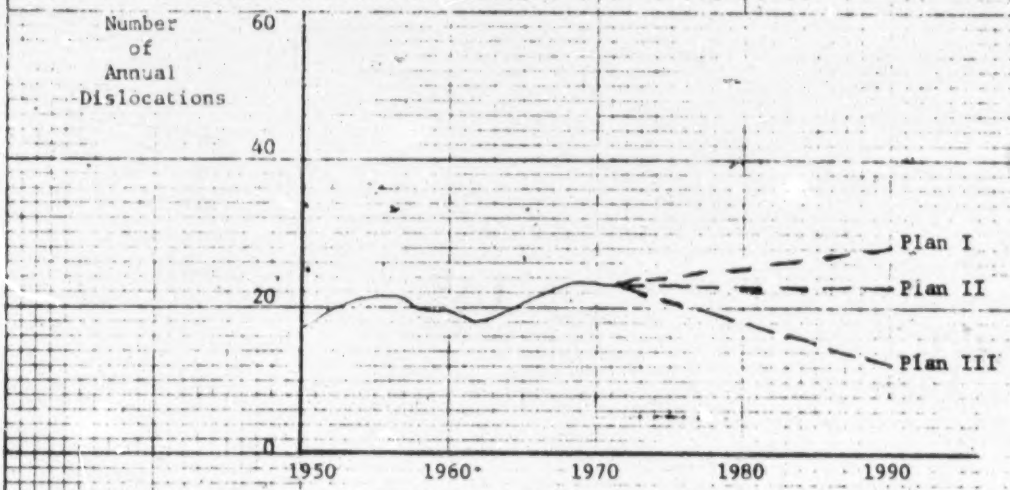

Figure 6 - Sample Display of Historical and Possible Future Residential Dislocations

Figure 6 illustrates a very basic point in the development of information for consideration by decisionmakers. Too often the set of data we present has little meaning to those for whom it was developed simply because we fail to provide a basis for comparison. A simple device such as the historical trend line plot shown in figure 6 can provide the insight needed to intelligently absorb and appraise a multitude of data.

D. Some Principles for Guiding the Selection of Evaluation Criteria

Emerging from the foregoing discussion is a brief set of guiding principles, which can be considered in developing evaluation criteria.

1. They should be developed on the basis of adopted regional and subregional goals and objectives.

2. They should comprehensively cover all factors which decisionmakers will use to evaluate and choose among alternative plans.

3. They should have the explicit approval of a policy body.

4. They should be capable of being measured and forecasted.

5. They should be clearly and concisely developed and presented, so as to be meaningful to professional, decisionmaker, and layman alike.

IV. SYSTEMS TO EVALUATE ("Let No Stone Go Unturned")

While quite abviously no general rule can exist to govern the precise number and type of plan alternative to be examined, a few basic concepts can be applied to most situations. Normally the number of alternatives will depend upon the size and complexity of the urban region, the rate at which the region is growing, the requirements of decisionmakers and the public, and the financial and staff resources of the planning program. As a minimum, two systems which should be subject to evaluation, and which are frequently overlooked by many urban transportation studies, are (1) the existing system under current conditions, and (2) the existing (plus committed) system under future conditions.

A. Evaluating the Existing System With Existing Travel

Applying the full array of plan evaluation procedures to a base year system with base year travel is a step practiced by few transportation studies. Yet there are at least three basic advantages to performing such an exercise.

1. Appraising the Performance of the Existing System

Performing an evaluation of base year conditions represents an excellent method for determining and reporting upon the existing performance characteristics of the regional transportation system. Measures such as accessibility, speed, volume to capacity ratios, and so on can be used to isolate current deficiencies, which can provide the factual basis need for an immediate action program. Such a program may be advocated by a transportation study well in advance of developing or updating the long range regional land use/transportation plan. Thus, a useful service is provided, and the credibility of the entire planning process may be improved.

2. Testing Evaluation Procedures

The process of developing, testing, and evaluating a land use/transportation plan may consume many months, if not years. The process can be streamlined to a certain extent by developing evaluation criteria, and an evaluation technique in advance of their application to future systems, and testing the utility of these criteria and procedures by applying them to base year conditions. This enables the fine tuning of the evaluation system, and builds experience with and confidence in the procedures on the part of both the technical staff and the policy group.

3. Providing a Key Benchmark Against Which Future Alternatives May Be Compared

A major problem with much of the planning information provided through evaluation of future alternatives lies in the difficulty in placing all this data within a comprehensible context. For example, a range in system speeds among future alternatives from 25 to 30 miles per hour may have little meaning unless current average speeds are known for the sake of comparison. Similarly, an annual consumption of 150 acres of land for transportation purposes under a proposed alternative becomes a much more meaningful number if it is knownwhat the average annual rate for the past few years has been.

Thus, by comparing future alternatives,not only to each other, but to current conditions, a valuable frame of reference is provided facilitating more intelligent judgments.

B. Evaluating the Existing (Plus Committed) System With Future Travel (Do-Nothing Alternatives)

Too often, planners fail to clearly indicate to policy officials and to the public, the consequences of completely halting the program of transportation improvements within an urban region. While such an action may appear unthinkable, recent experience with controversial transportation projects within urbanized areas has shown that the burden of demonstrating the need for a sustained program of capital improvement rests squarely with those government agencies and officials who have such responsibilities. Unless we can demonstrate the consequences of doing nothing, it will become increasingly difficult to do anything.

C. Evaluating Future Alternative Plans

While the evaluation of current conditions and the do-nothing alternative are to be strongly advised, the principal focus of the evaluation process will be the discrete number of land use/transportation alternatives which emanate from the plan development and testing phases. These alternative plans become the object of an intensive series of probing analyses which have been designed to evaluate the worthiness of each culminating in the selection and adoption of the most desirable one.

V. EVALUATION PROCEDURES ("Beware of Numbers - They May Not Lie, But They are Capable of Masking the Truth")

The principal objective in selecting an evaluation technique is to arrive at a procedure which is capable of (1) incorporating a varied mix of seemingly incompatible evaluation criteria, (2) applying these criteria to the information gleaned from each plan, and (3) indicating which plan best meets the stated community objectives. Quite a few techniques have evolved over recent years, and several of these will be described in the next paragraph.

A. Plan Information Matrix

The plan information matrix approach represents the most direct, and uncomplicated method of all. As shown in table 3, where the P.I.M. simply involves the listing of all previously established evaluation criteria, and the tabulation of all raw, unadjusted data associated with each plan, for each criterion. While this approach places on the policy group the burdens of distinguishing among criteria in terms of importance, and of absorbing a wealth of information for each of the many criteria, it has the advantage over the techniques subsequently described of avoiding the burying of key information behind a maze of weights, rates, ranks, and scores. Using the P.I.M., therefore, facilitates the process of tradeoffs and compromise by dealing directly with data, in terms understandable by everyone, rather than dealing with the abstract numerical scores or rankings which characterize some of the more esoteric procedures.

B. Value Profile Method*

The value profile method used in Twin Cities is another relatively simple approach to making evaluations based on numerous criteria. As shown in figure 7, value profiles can be drawn for various plans (in this case land use plans rather than transportation plans) showing their relationship to evaluation criteria which in many cases are not subject to quantitative measurement. This results in a graphical comparison of the extent to which the various goals are satisfied. In applying the method to transportation plan evaluation, evaluation criteria are represented by value couplets composed of two reciprocal elements or criteria. One of the elements should correspond to satisfactory fulfillment of the goal, while the other would represent an undersirable situation. The value couplets are then arrayed

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* Much of the description of this and subsequent procedures draws directly from a summary of evaluation techniques prepared by David S. Gendell of the Urban Planning Division.

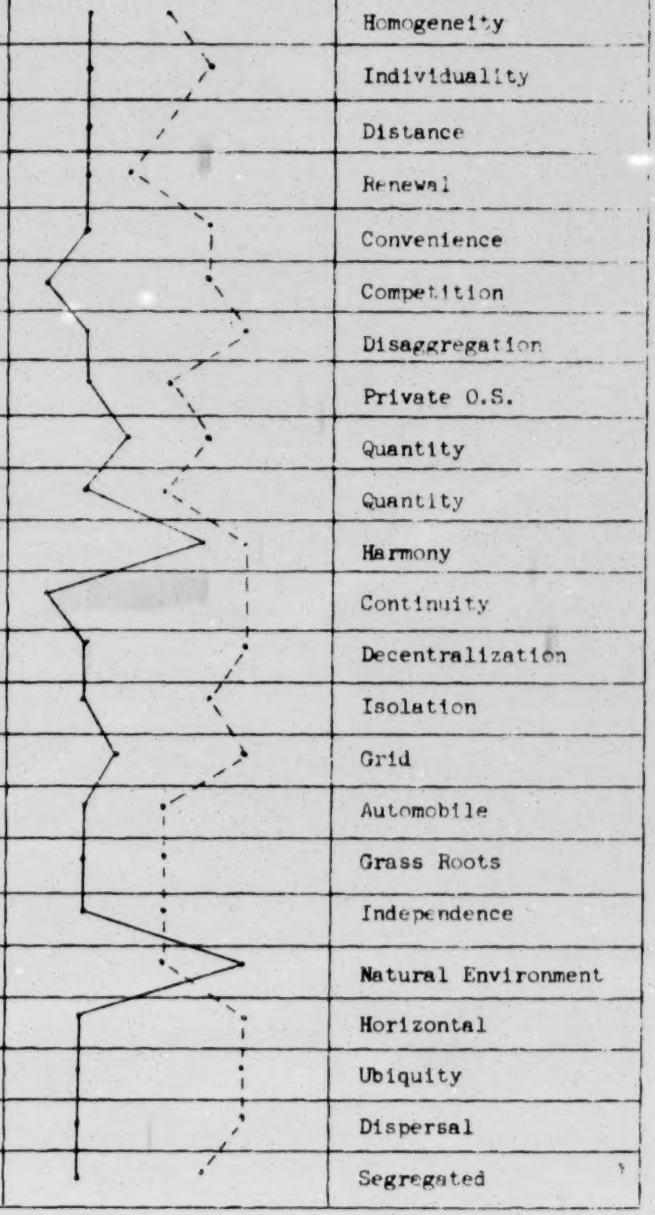
Table 3

Sample Plan Information Matrix

Sample Evaluation Criteria	Current System Performance or Recent Trend	Plan Alternative			
		E + C	A	B	C
Annual Capital Cost ($ million)	25.0	4.1	21.6	29.7	38.1
Mean Effective Speed (m.p.h.)	24.0	17.0	22.0	25.0	28.0
Accidents per 100 million VMT	3.1	4.2	3.7	2.9	2.7
Daily Transit Seat Miles per Thousand Capita	33.0	39.0	37.0	36.0	36.0
Average Annual Dislocations					
1. Residences	25	8	15	29	87
2. Businesses	13	4	11	15	22
Annual Taxable Land Consumption (Acres)	36	9	31	43	62
Plan Preference	--				

Figure 7.--Value Profiles for Two of Twin Cities Alternative Land Use Plans

Plan A ——— Plan B -------

GOAL AREA	DESIRABLE RECIPROCAL CRITERIA	VALUE PROFILES	UNDESIRABLE RECIPROCAL CRITERIA
HOUSING	Heterogeneity		Homogeneity
	Identity		Individuality
	Convenience		Distance
	Rehabilitation		Renewal
COMMERCE	Choice		Convenience
INDUSTRY	Cooperation		Competition
	Aggregation		Disaggregation
OPEN SPACE	Public O.S.		Private O.S.
	Quality		Quantity
	Convenience		Quantity
	Contrast		Harmony
PUBLIC FACILITIES	Efficiency		Continuity
TRANSPORTATION	Centralization		Decentralization
	Congestion		Isolation
	Radial		Grid
	Mass Transit		Automobile
GOVERNMENT	Metro Affairs		Grass Roots
	Interdependence		Independence
URBAN DESIGN	Man-made Env.		Natural Environment
	Vertical		Horizontal
	Diversity		Ubiquity
	Concentration		Dispersal
	Integrated		Segregated

within their goal area with the desirable "reciprocal criteria" on one side of the rating box and the undersirable ones on the other. The consensus concerning the ability of the plan to achieve the desirable reciprocal criteria is represented by a point, as shown in figure 7. The points are then connected, and the result is a value profile for the plan. By plotting more than one profile on the same figure, graphical evaluations of alternative plans can be made. This method appears to have particular merit in presenting plan evaluation to laymen. One disadvantage of the value profile approach lies with the implicitly equal contribution of each criterion as it influences the position of the lines.

C. Rank-Based Expected Value Method

The rank-based expected value method was used by the Southeastern Wisconsin Regional Planning Commission to evaluate nonquantifiable as well as quantifiable elements of alternative land use plans. The method is also applicable to transportation plans.

In this method, plans are ranked according to their ability to satisfy standards within a given objective. Additionally, the objectives are ranked in order of importance. In both instances, the most desirable situation is assigned the highest rank number. Since plans have different probabilities of implementation, this element is brought into the analysis. This is accomplished through an adjustment to the plan score.

Table 4 illustrates the method. The planning objectives (across the top of the table) are ranked in order of importance with the most important, "serve land use pattern and meet travel demand," being assigned a rank value of 3. The plans are then ranked on their ability to satisfy each objective. Since this is a summary evaluation table, this decision is based on the plan's overall ability to satisfy the standards, and, therefore, objectives which make up the major objective groups. In the case of the second objective group, the controlled existing trend plan satisfies the component standards the best and is given a rank of 3. The rest of the ranks are then completed and the probability of implementation entered. The plan value or score is then obtained by multiplying the rank value or each planning objective by the rank value for the particular plan's ability to meet that objective and then summing the similar values across the table. The resultant value is then multiplied by the probability of implementation. For

Table 4

Rank-Based Expected Value Method

Plan \ Major Group Objective		Serve Land Use Pattern and Host Travel Demand Rank Order of Group Objective = 3 Rank Order Value of Plan	Provide Appropriate Transportation at an Adequate Service Level Rank Order of Group Objective = 2 Rank Order Value of Plan	Provide for an Economical Transportation System Rank Order of Group Objective = 1 Rank Order Value of Plan	Plan Value
Controlled Existing Trend	Probability of Implementation = 0.6	2	3	3	9.0
Corridor	Probability of Implementation = 0.3	3	2	2	4.5
Salellite City	Probability of Implementation = 0.1	3	1	1	1.2

the controlled existing trend plan, this would give $[(3x2) + (2x3) + .(1x3)] 0.6 = 9.0$. The plan with the highest plan value is considered to be the best.

In its application of the method, SEWRPC did not always assign the maximum value to the best plan. If none of the three plans satisfied a standard but one was better than the two, the best plan would be given a value of 2 and the other plans values of 1. Thus, a major drawback of the procedure was partially overcome. This drawback is the fact than, in general, the plans are ranked rather than rated Thus, if three plans have values of 10, 9, and 2 for a particular standard where high numbers are desirable, the plan with a value of 10 would be given a rank of 3, the one with 9 a rank of 2, and the one with a value of 2 a rank of 1. The scale of the standard would be obscured.

Serious question also exists concerning the use of the probability of implementation factor at this point in the evaluation. For example, it can be seen from table 4 that even if the Satellite City plan were ranked highest in all categories, with a probability of implementation of 10 percent, its plan value would still be only 1.8 which is far below the next highest scoring plan.

D. The Value Matrix

The next method, the value matrix, is essentially an extension of the rank-based expected value method and has been applied in several areas. In this case, the goals, objectives, and evaluation criteria which will be used in plan evaluation are weighted to reflect their relative degree of importance. The weights of the goals, objectives, and evaluation criteria should reflect those of the community or at least those of the community's decisionmakers.

Once the goals, objectives, and evaluation criteria have been established and weighted, data are obtained concerning the relation of the various plans to the individual evaluation criteria. This information can be in monetary terms, other quantifiables, or of a qualitative nature. The individual plans are next rated on a scale of 0 through 10 according to how well they satisfy the evaluation criteria and a summation made to produce a plan score as it was in the rank-based expected value method.

A sample value matrix is shown in table 5. Across the top of the matrix are several goals which form the foundation for related objectives and evaluation criteria. Across the fourth row are the various weights developed for each evaluation criteria. To be valid, these weights must reflect the composite priorities of the group performing the evaluation. Under the weights are shown the data for each plan. Depending upon the data, each plan receives a rating from 0 to 10 (shown in bold face). For example, under the user cost criterion, Plan A, which has the highest user costs received a zero rating while Plans C and D which have the lowest user cost received a rating of 9. These rating are multiplied by the criteria weight of 1.3, with the products added to remaining products of rating and criteria weights, yielding the plan scores shown in the column on the far right.

Items which are not included in the value matrix are considered either as contraints, or involve trade-offs between the plan score and the item under consideration. Plans which fail to meet constraints can be eliminated from further consideration.

The constraints can be thought of as a means of overcoming the problem of using one particular value for the weight of each evaluation criteria regardless of the performance of the various plans. For example, an objective might be represented by the evaluation criteria, number of acres of park land taken, and we might have several plans which take anywhere from no park land at all to all of the park land in the region. The problem is that the first few acres of park land taken may have a lower value to the community than the last few acres taken, yet a uniform value in terms of the weight of the evaluation criteria is used for all plans. By using constraints, this problem of marginal utility is partially overcome by putting an infinite weight on those evaluation criteria that are not satisfied to at least the minimum value of the constraint.

The other items considered outside of the value matrix involve the trade-offs with the plan score provided by the value matrix. An example of considerations handled in this manner would be the result of an economic evaluation or more simply the capital cost to construct the system. The decision as to which plan is best then boils down to one of cost-effectiveness in which the construction cost is weighted against the effectiveness as measured by the plan score.

TABLE 5.--THE VALUE MATRIX

GOAL	[illegible] EFFICIENT REGIONAL TRANSPORTATION		ENHANCE ENVIRONMENTAL, SOCIOLOGICAL, AND ESTHETIC VALUES				PROVIDE A SAFE SYSTEM	PLAN SCORE
OBJECTIVE	[illegible] USER COST	MINIMIZE INDIRECTION	MINIMIZE AIR POLLUTION	MINIMIZE DISLOCATION		PROMOTE ESTHETICS	MINIMIZE ACCIDENTS	
EVALUATION CRITERIA	USER COST (000)	VMT (000)	VHT (000)	DWELLING UNITS TAKEN	BUSINESSES DISRUPTED	RATE PLANS	ACCIDENTS	
[illegible] PLAN	1.3	1.9	1.1	0.7	0.4	1.0	3.6	
A — DATA	200	1,820	5,030	0	0	4	4,440	
A — RATING	0	6	4	10	10	4	3	42
B — DATA	170	1,750	4,750	14	6	6	4,310	
B — RATING	6	7	5	9	8	6	4	57
C — DATA	160	1,760	3,910	203	10	7	3,880	
C — RATING	9	7	9	7	7	7	8	78
D — DATA	160	1,750	4,160	344	11	6	4,040	
D — RATING	9	7	8	5	7	6	6	68

VI. CONCLUSION ("The Measure of Success is Not in the Doing, But in the Deeds")

The evaluation of alternative long range plans represents one of the principal focal points in a continuing, comprehensive land use/transportation planning effort. Into this key phase of the planning process flow the numerous elements which characterize a long range regional planning program: data collection, formulation of goals, objectives, and evaluation c criteria, development of land use and travel models, forecasts of the magnitude and distribution of urban activities, formulation of land use and transportation system alternatives, and the development of travel projections by purpose, mode, time, and orientation. Out of this, vast collection of information must emerge those items of data necessary for a group of normally nontechnical, policy oriented individuals to render intelligent judgments concerning the relative mertis of plan alternatives.

To succeed this process requires a clear definition of regional goals and objectives, translated into meaningful, and acceptable evaluation criteria. It requires an understanding and acceptance on the part of the policy group and the technical staff as to their relative roles and responsibilities. And it requires the use of procedures which are capable of providing the information required by decisionmakers, in terms clear and understandable to them. However, unlike more technically oriented aspects of the planning process, there is no inherently correct method for performing plan evaluation. The effectiveness of the evaluation effort depends not so much on how it is done, but on what it has produced. If it produces an adopted long range plan and short range program which are generally accepted by the community, which serve as the basis for decisions of regional importance concerning transportation improvements and urban development, then it may be safely assumed that the evaluation process has succeeded. On the other hand, regardless of how sophisticated the approach, if the plan and program which are ultimately recommended merely serve as a facade, and actually have relatively little effect on major decisions of the type just described, then the effort must be characterized as less than successful.